

## Knowledge Base in a Natural Language

1. Marcus is a person.
2. Marcus is a Pompeian.
3. All Pompeians are Roman.
4. Caesar is a ruler.
5. All Romans are either loyal to Caesar or hate Caesar.
6. Everyone is loyal to someone.
7. People only try to assassinate rulers to whom they are not loyal.
8. Marcus tried to assassinate Caesar.

**Query:** Does Marcus hate Caesar?

## Knowledge Base in First Order Logic

**Constants:** Marcus, Caesar

**Predicates:** People( $x$ ), Pompeian( $x$ ), Roman( $x$ ), Ruler( $x$ ), Loyal( $x,y$ ), Hate( $x,y$ ), Assassinate( $x,y$ )

1. People(Marcus)
2. Pompeian(Marcus)
3.  $\forall x \text{Pompeian}(x) \rightarrow \text{Roman}(x)$
4. Ruler(Caesar)
5.  $\forall x \text{Roman}(x) \rightarrow [\text{Loyal}(x, \text{Caesar}) \vee \text{Hate}(x, \text{Caesar})]$
6.  $\forall x \exists y \text{Loyal}(x, y)$
7.  $\forall x \forall y (\text{People}(x) \wedge \text{Ruler}(y) \wedge \text{Assassinate}(x, y)) \rightarrow \neg \text{Loyal}(x, y)$
8. Assassinate(Marcus, Caesar)

**Negation of Query**  $\neg \text{Hate}(\text{Marcus}, \text{Caesar})$

**Knowledge Base in CNF**

1. People(Marcus)
2. Pompeian(Marcus)
3.  $\neg$ Pompeian( $x_1$ )  $\vee$  Roman( $x_1$ )
4. Ruler(Caesar)
5.  $\neg$ Roman( $x_2$ )  $\vee$  Loyal( $x_2$ , Caesar)  $\vee$  Hate( $x_2$ , Caesar)
6. Loyal( $x_3$ ,  $F(x_3)$ )
7.  $\neg$ People( $x_4$ )  $\vee$   $\neg$ Ruler( $x_5$ )  $\vee$   $\neg$ Assassinate( $x_4$ ,  $x_5$ )  $\vee$   $\neg$ Loyal( $x_4$ ,  $x_5$ )
8. Assassinate(Marcus, Caesar)

**Negation of Query**  $\neg$ Hate(Marcus, Caesar)

**Resolution Proof**

Sentence 1	Sentence 2	SUBST	Result
Query	5.	$\theta = \{x_2/\text{Marcus}\}$	9. $\neg$ Roman(Marcus) $\vee$ Loyal(Marcus, Caesar)
9.	3.	$\theta = \{x_1/\text{Marcus}\}$	10. Loyal(Marcus, Caesar) $\vee$ $\neg$ Pompeian(Marcus)
10.	2		11. Loyal(Marcus, Caesar)
11.	7.	$\theta = \{x_4/\text{Marcus}, x_5.\text{Caesar}\}$	12. $\neg$ People(Marcus) $\vee$ $\neg$ Ruler(Caesar) $\vee$ $\neg$ Assassinate(Marcus, Caesar)
12.	1.		13. $\neg$ Ruler(Caesar) $\vee$ $\neg$ Assassinate(Marcus, Caesar)
13.	8.		14. $\neg$ Ruler(Caesar)
14.	4.		

Contradiction found. Therefore, we can conclude that Marcus hates Caesar.